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MARINE CORPS OPERATIONS ANALYSIS GROUP

INTERIM-INPUT OUTPUT RESOURCE ALLOCATION MODEL

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and
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CNA Research Contribution No. 134

This Research Contribution does not necessarily represent the opinion of the Commandant, U.S. Marine Corps.

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CONTRACT N00014-68-A-0091

Center for Naval Analyses
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1401 Wilson Boulevard Arlington, Virginia 22209 703/524-9400

(CNA)37-70
2 March 1970

FORWARDING OF CENTER FOR NAVAL ANALYSES RESEARCH CONTRIBUTION NO. 134

Encl: (1) CNA Research Contribution No. 134, "Interim Input-Output Resource Allocation Model"

1. Enclosure (1) is forwarded as a matter of possible interest.

2. CNA has constructed an input-output model of the U. S. Marine Corps. This model accounts for and allocates indirect operating costs created by the many interactions between Marine Corps units. The model is described in this Research Contribution.

3. The comprehensive, advanced model will be more fully described and documented in MCOAG Study Report No. 6, to be published shortly. This study report will include a description of the computerized model. The early version of the model in summary form is being published in this Research Contribution so that the principles and techniques of the methodology and its application can receive wider distribution.

4. This Research Contribution represents the opinions of the authors and is distributed because of the interesting use made of input-output analysis. While the model is built around the Marine Corps force structure, it has not been approved or used by the Marine Corps.

5. Additional copies of this Research Contribution may be obtained from the Center for Naval Analyses.

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CNA RESEARCH CONTRIBUTION NO. 134

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Work conducted under contract N00014-68-A-0091

Enclosure (1) to
(CNA)37-70
Dated 2 March 1970

ABSTRACT

This research contribution describes the Interim CNA Input-Output Resource Allocation Model. This model is an "input-output" model, which accounts for and allocates indirect operating costs created by the many interactions between Marine Corps units. The cost model provides 3 types of information. One, it provides direct operating cost for all Marine Corps organizations on the east coast, both Fleet Marine Forces (FMF) and non-FMF. Second, it allocates the operating costs of the support establishment (normally called indirect support costs) to the FMF units receiving the support. Third, it provides estimates of the effect of any specified change in the FMF upon the support establishments' operating costs, and estimates the needed additional resources, including manpower, of the change.

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SYNOPSIS

This Research Contribution describes the Interim Input-Output Resource Allocation Model (REALM), conceived, structured, and constructured by the Marine Corps Operations Analysis Group (MCOAG) of the Center for Naval Analyses. The ultimate goal of this project was the design of a comprehensive cost model for consideration and use by the U.S. Marine Corps. The comprehensive model, to be described in MCOAG Study No. 6, was submitted to the U.S. Marine Corps, who, after considering this final model, found that it was not suited to the Marine Corps' capabilities and needs. However, because the model's input-output structure represents a significant departure from the methodology of other cost models, thereby offering cost analysts a new approach to force level costing, the Center for Naval Analyses has published this research contribution describing the model.

REALM is a force structure cost model designed to estimate indirect as well as direct operating costs for any FMF, Atlantic, ground or supporting units; East Coast Marine Training; Marine Corps East Coast base facilities; and the operations of most Marine Corps East Coast supply activities. It includes no components of Marine Aviation.

The costs provided by the working version of the interim model deal with the costs contained in the appropriations categories Military Personnel, Marine Corps (MP, MC); and Operations and Maintenance, Marine Corps (O&M, MC) for the above activities; and that part of the Procurement, Marine Corps, account used by these activities in normal operations and maintenance. Thus, it excludes costs for Reserve Personnel, Marine Corps; and most of Procurement, Marine Corps; Research and Development, Marine Corps; all Navy appropriations, including military construction (MilCon). Moreover, it does not consider MP, MC and O&M, MC for any activities other than those specified.

REALM is structured as an "input-output" model. This type of model systematically accounts for all relationships between Marine organizations. The advantage of using input-output analysis is that this approach not only calculates the operating cost of an isolated component of the Marine Corps, say a regiment, but also estimates the indirect support that component receives from all other Marine organizations. The input-output structure of the interim model means that it has a greater ability than other cost models to estimate indirect operating costs.

In REALM's "input-output" framework, the total Marine Corps structure is divided into sectors, each containing one or more closely related organizations. These sectors are, in turn, divided into 2 groups, final users and processors. The final users produce the military output, the final output, of the Marine Corps. This military output is not measured by the model. That is, no attempt is made to measure the combat effectiveness of any unit. However, the size and number of the combat and combat support organizations is measured. Processors are those organizations who provide a service, usually measured in physical units; their service is a physical (real) input to other sectors. Supply companies, maintenance battalions and schools are examples of processor sectors.

In addition to real inputs, each sector requires dollar inputs, called primary inputs, that correspond roughly to the cost categories of the "expense operating budget" (EOB) of Project Prime. All primary (dollar) inputs together comprise the total operating costs of each sector.

These sectors are arranged in a pattern, a "matrix," that compactly pictures their inputs and outputs. This matrix of inputs and outputs can be algebraically manipulated to show all direct and indirect resources, manpower in particular, that each sector uses, as well as all dollar inputs, necessary to directly and indirectly support each sector's mission. This matrix can be further manipulated to estimate the resources and dollars required to support any specified change in a combat support unit. These estimates are based on the assumption that each support organization costs change proportionally with changes in their output. Finally the model can generate cost factors useful for quick reference.

The model's estimates are based on the relationships it derives by algebraic manipulations from the preceding year's data. The model only provides a picture of what relationships were between the support establishment and combat forces in the preceding year. In no case does the model attempt to find optimal, or best, inputs for any sector. If operating conditions change, the model's relationships are invalid and new data reflecting the changed conditions must be entered before meaningful estimates can be obtained.

The interim model assumes that changes in the number or size of sectors will require the same additional inputs that the "average" unit does. This condition also implies that each Marine organization carries out its activities in standard ways that, in turn, consume constant mixtures and amounts of all inputs. These assumptions are too restrictive, and can be refined.

I. INTRODUCTION

The Commandant of the Marine Corps in 1966 asked MCOAG to design a comprehensive cost model for the Marine Corps (reference (a)). The first step towards this objective was the development of an interim model. This publication outlines the structure of the interim model, reviews data sources, and demonstrates how such a model can be used.

The comprehensive Input-Output Resource Allocation Model designed by MCOAG will be described in a later CNA publication. The input-output structure of the model was reviewed by the U.S. Marine Corps and found not suited to the Marine Corps capabilities and needs. Thus, the Marine Corps did not adopt the cost model presented here.

THE NEED

The need for a cost model arose because the Marine Corps' modern management techniques generated a demand for accurate and detailed cost estimates. In addition, the Marine Corps must rapidly provide DoD with costs for a wide assortment of Marine activities. These requirements have imposed an increasing need for a unified system able to generate cost estimates rapidly and accurately.

THE TYPE OF PROBLEMS

The cost information required can be best illustrated by reviewing some recurring problems for which Marine Corps Headquarters must provide cost estimates.

Internal Management Problems.

First, Marine Corps Headquarters must provide costs for its own management efforts in 3 areas: the determination of optimal alternative force structures: the construction of effective plans: and the evaluation of alternative equipment and systems, primarily through cost-effectiveness studies.

Evaluating Structural Changes. Many Marine Corps staff agencies must continually reassess structural aspects of the organizations within their cognizance. In general, this involves finding the optimum size, as well as the optimum components, of such organizations. Structural re-evaluations are also necessary if the introduction of new equipment radically changes either an organizations' capabilities or support requirements. For example, current projects include finding the optimal structure of intelligence units, such as radio and reconnaissance battalions. Before any alternative may be selected, the costs of each must be known.

Building Effective Plans. Planning generates a continual need for detailed cost information. For example, planning for reduction in Southeast Asia forces must consider the indirect or derived effects that force contraction could have on such non-combat support units as schools and supply facilities. Furthermore, the costs of the alternatives must be found rapidly to compress the time required to construct a plan.

Constructing Cost-Effectiveness Studies. Rapidly changing technology has occasioned many cost-effectiveness studies on hardware, equipments and systems. Cost-effectiveness studies lose their value unless all direct and indirect costs for the alternatives can be assessed.

External Requirements.

Although the Marine Corps responds to many deverse DoD requests for data, most are needed by the integrated Planning, Programming and Budgeting System (PPBS). Because such information must feed current budgetary decisions, timely and accurate cost estimates are crucial. The time pressure has caused DoD to limit preparation of Service comments to 30 days after receipt of various Draft Presidential Memoranda (DPM). These reviews of DPM's, which include examining any changes that the Service wishes in it, must detail the costs for each alternative.

ESSENTIAL FEATURES OF A USEFUL COST MODEL

From this survey of cost-centered problems, it is clear that 3 types of cost information are required. One, a useful cost model must provide detailed operating costs for every unit. These costs are normally called direct costs. Second, operating costs for the supporting establishment must be allocated to the combat and combat support units whom they support. Third, the model must be able to forecast the effect, in dollars and resources, of changes in force structure, including the effect on the supporting establishment of any change. The importance of capturing indirect costs was recognized early and strongly emphasized in DoD guidance on cost models (reference (b)):

> "The service-wide cost model should reflect the impact of the force structure on all significant costs including indirect (also called 'support') as well as direct costs. Special effort is needed to develop valid ralationships between various indirect costs and changes in force levels. Distinction needs to be made between those portions of support activities which are 'fixed' and those which 'vary' in some way with the force level.... there may be substantial difficulty in uncovering these support cost relationships, which.... are likely to be quite complex. However, rather than ignoring the impact of such activities, it is preferable to use even rough relationships."

Because of the need for a model that will estimate indirect costs, REALM has been designed as an "input-output" model. This type of model systematically accounts for all interrelationships between organizations, and thus can accurately estimate indirect costs.

REALM can provide this information quickly. Rapid response is advantageous because the number of alternatives considered frequently depends directly on the time needed to cost each alternative. The model can greatly increase the alternatives considered.

The Scope of the Interim Model

The interim model was the first step in designing the final version of REALM and was not designed to provide the cost information outlined above for the entire Marine Corps. Its scope is limited to cost data based on units of the Second Marine Division and Force Troops at Camp Lejeune, North Carolina, and other organizations within FMF, Atlantic, plus those Marine organizations and commands that support these forces.

Cost Information in the Interim Model

Costs are usually grouped into 3 categories: research and development, operating and investment. REALM provides operating cost information for the FMF, Atlantic, organizations plus those Marine activities that support these forces. Operating costs in the interim version of REALM include all costs of operating the unit. Thus, it includes not only the funds from Military Pay, Marine Corps, and Operations and Maintenance, Marine Corps, but also those items purchased from the Procurement, Marine Corps, account that are used for normal operations and maintenance, such as training ammunition. These items are provided to organizations by the Appropriations Stores Account (ASA) and the costs presented here represent statistical charges for Appropriations Stores Account items incurred by the organizations in the model.

In the working version of the interim model described here, this operating cost data was obtained for fiscal 1967 for all units contained in the interim model. Data for military pay were computed from Nav Comp Instructions 7041.3A and the appropriate Tables of Organizations. Operations and Maintenance expenses were obtained from local fund resource ledgers or comptroller reports. The statistical charges for Appropriations Stores Account items, with the exception of training ammunition, were identified in the fiscal year 1967 local fund resource ledgers and comptroller accounts. Training ammunition costs were determined from prices supplied by NavOrd 0D12067-L (1 July 1967) and allowances established in Marine Corps Order 8011.4B, 22 June 1964. For the Officer Candidate School, the Basic School, and the Recruit Training Regiments of the recruit depots, an allowance for initial clothing issue and recruiting costs are entered.

Representative types of operating cost information available in the interim model include:

- All direct and indirect operating costs of all Marines in the FMF, Atlantic, and all units supporting them. The direct operating cost of an organization includes the pay and allowances of the Marines in it, its operations and maintenance costs, and its share of the ASA. Indirect costs include the operating costs of recruit training, advanced or special training of Marines in the organization, and an estimate of the share of the base's operating costs supplied to it via base support.

- The approximate direct and indirect operating costs of training a Marine in a career speciality. These costs are clustered around general groups of career fields. Thus, the cost of training in communications-electronics can be given, but not the costs of any specific MOS within that field.

- All operating costs associated with weapons or support systems identified with units, such as tank or artillery battalions.

- All resources provided by Marine base maintenance organizations for their tenants. However, the costs of constructing or maintaining family housing, dependents' facilities, and commissaries are not included.

- All operating costs of operating the 4 Remote Storage Activities (RSA's) that supply FMF, Atlantic, organizations, and the costs of all east coast organizations that support these RSA's. However, the cost of operating the Inventory Control Point at Philadelphia is not included.

- All operating costs needed to conduct fifth echelon maintenance and rebuild programs at the Marine Corps Supply Center at Albany, Georgia.

The interim model does not include any costs for:

- FMF, Pacific, units and their supporting organizations.
- Any Marine organization in the western Pacific theater.
- Personnel, activities, organizations, or equipment paid by Navy appropriations.
- Marine air organizations.
- Marine Corps Reserve units.

The Model's Operation

The model provides 2 basic types of costs. One, it provides direct operating costs for all Marine Corps units, combat and support, in the model. These costs are extracted from fiscal 1967 data. Second, it provides estimates of how the operating costs of support units change as a result of specified changes in combat units. These changes are frequently called indirect support costs.

The model makes these estimates of indirect support costs by calculating functional relationships between the force levels of the combat forces and the output of the support establishment. It costs out this support by assuming that there is a proportional relationship between the output of each support organization and the support organization's operating cost.

The functional relationships derived by the model from this basic data can be used for structural analysis and prediction. By structural analysis, we mean an analysis of how much of each support organization's support goes to the various combat organizations. This includes an estimate of how much of the support organization's operating costs are used to support each combat unit. By prediction, we mean estimating how specified changes in the combat organizations affect the support establishment. The model does this by using its structural relationships that it derived from the basic data.

These estimates of the future effect depend upon the assumption that the relationships found in the base year will continue to hold in the future. If the basic relationships change, the model's estimates are invalid. The assumption that the relationships will not change are based upon the knowledge that each Marine organization in garrison maintains an average or typical level of operations, training and support. Prediction of the effect of changes in the combat forces depends upon these typical levels of operations being maintained.

The model obtains its cost figures from one set of data. For the interim model, this set consists of data for fiscal 1967. However, the set need not be one year's data. The set can be any data the cost analyst wishes to use as, for example, an average of several years' data.

OUTLINE OF THE STUDY

Section II discusses the problem of allocation of support costs and outlines how the input-output structure of the interim model solves this problem. The general characteristics of economic input-output models are discussed.

The major features of the interim model are discussed in section III.

Section IV considers hypothetical, but representative, problems for which the interim model can provide costs.

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II. INPUT-OUTPUT ANALYSIS

To show how the "input-output" structure of the interim model deals with the problem of indirect costs, the nature of indirect costs must first be examined.

THE NATURE OF INDIRECT COSTS

Indirect costs are created by the many supporting services that Marine organizations give each other. Support organizations directly support combat organizations and also support each other. Input-output analysis picture these support relationships as they existed for one period. To make projections with these interrelationships, input-output analysis has to make assumptions about these relationships. In particular, input-output analysis assumes that the nature, form and extent of the support relationships will not change. Examples of this assumption are that all recruits will continue to undergo 8 weeks of training, that all regiments will have 3 battalions, and that training ammunition will be consumed at the same rate. Second, input-output analysis assumes that there will be no substitutions between the relative amounts of support each combat organization incurs.

It is clear that these restrictions are too severe considering that last year's relationships and costs are the result of certain decisions which are subject to change. Furthermore, there may be a revision of certain relationships. However, for planning purposes, last year's structure will certainly be the beginning basis of any decisions made this year. It is on this basis that the assumptions of input-output analysis can be used to make projections.

Assuming unchanged support relationships, adding a new combat organization causes each supporting organization to give more support. Each of these increases then causes each support organization to demand more support from other support organizations. This leads to further derived demands. The full effect of the initial change thus ripples back and forth through the system, creating additional changes. The sum of all these changes are indirect costs. This sum is part of the total cost of a force structure change.

This analysis highlights 2 critically important considerations. First, each component of the Marine Corps is linked in a variety of ways to many other components. Second, the costs of each component cannot be considered without taking the entire structure, or system, of the Marine Corps into account.

THE INPUT-OUTPUT SOLUTION

Input-output analysis is the one basic framework that meets these criteria. Models based on this framework can not only picture this web of interrelationships, they can also be used to identify the costs associated with them.

Consequently, the interim model has been designed as an input-output model. This model treats the Marines as a single, unified system with many interconnected parts. As an input-output system, it presents a picture of these interrelations.

Essentially, input-output analysis breaks the Marine Corps "system" into basic components, called sectors. Generally, each sector is a clearly delineated activity. In most cases, it consists of one organization, usually a battalion or regiment. However, each clearly defined base facility, such as maintenance shops, are generally detached from their parent organization and treated as a separate sector. Chapter III lists the sectors used in the interim cost model.

These sectors are arranged in a specific pattern that shows clearly their interaction to form a system. This is achieved by first dividing the sectors into 2 groups: Group I includes all organizations in the support establishment (called supporting organizations); Group II includes all combat organizations. In the model, the combat organizations do not provide any output. Each support sector provides a clearly measurable service (output) for other sectors (combat and support). These services range from repairing ordnance and vehicles to painting buildings, cooking, and training. Many of these services can be measured in specific units, such as vehicles repaired. A second type of output is provided by headquarters organizations. Headquarters perform a command and control function. Command and control includes administration, security, planning and supervision. We do not attempt to measure these different flows. Rather, we allocate the headquarters' output to its subordinate organizations on the basis of proportional TO strength.

The output that support organizations provide can be conveniently shown by organizing these sectors in a grid of rows and columns, or a matrix. Down the left side and again across the top of this matrix is the name of each support organization, so that the first organization is in row one and column one. Across each row is each sector's output in the column corresponding to the sector receiving the support. Thus, the output of one sector is the input to another (the name input-output stems from this basic relationship).

The basic grid does not show support given to the combat organizations. This support is listed on a second grid to the right of the basic grid. Each column of the second grid represents one combat organization. The total across each row, both to support and to combat organizations, is total output for that sector.

A simple example will show how this is done. Suppose 2 sectors, the maintenance company of service battalion and base motor transport, produce outputs measured in thousands of hours worked and thousands of miles driven, respectively. This system is shown in figure 1.

	1. Maintenance company service bn.	2. Base motor transport
1. Maintenance company (hours worked in thousands)	4	0
2. Base motor transport (miles driven in thousands)	22	128

FIGURE 1

Figure 1 shows that the maintenance company needs 22,000 miles of motor transport service and uses 4,000 maintenance hours of its own services. Motor transport requires no maintenance manhours from the maintenance company but does require 128,000 miles of motor transport service.

Maintenance company and base motor transport would typically use many inputs not created by Marine Corps organizations, including everything purchased from the civilian economy. They also include the pay and allowances that Marines and civilians in the organizations receive (these may be regarded as "purchases" of labor from the civilian sector). All such purchases are termed operating costs in the cost model. These dollars are written below the appropriate column of the grids, as shown in figure 2. Here 1.5 and 2.3 represent the value of the goods and services (in millions of dollars) that the maintenance company and base motor transport, respectively, require from the civilian economy.

Figure 3 represents the complete matrix when the support given by the support organizations to the combat organizations (here a single infantry regiment) is shown.

The basic form of input-output models in figure 3 is transformed into an operational tool by dividing the total output of each organization (sector) into its column of inputs. The result is a decimal fraction called an average input coefficient.

	A. Maintenance company	B. Base motor transport
A. Maintenance company	4	0
B. Base motor transport	22	128
Operating costs (millions of dollars)	1.5	2.3

FIGURE 2

	A. Maintenance company	B. Base motor transport	C. Infantry regiment
A. Maintenance company	4	0	8
B. Base motor transport	22	128	187
Operating costs (millions of dollars)	1.5	2.3	70

FIGURE 3

When multiplied by a hypothetical force level, the coefficients predict the total output required from each support organization to support that specified force level. These totals include all indirect effects created by the many interrelationships between the Marine Corps sectors. These outputs are then translated into dollars to show the total change in operating costs that any change in the output of one combat sector imposes on all support sectors throughout the system.

GENERAL ASSUMPTIONS

Having outlined the general features of the model, we may discuss now the main assumptions underlying its construction.

The first assumption holds that any change in an organization's output will cause it to demand a proportional change in each of its inputs. This assumes that each force level requires about the same mix of inputs as any other level. (A mathematician would say that the models' relationships are proportional.)

The second assumption is that each Marine organization maintains in garrison an "average" or "typical" level of operations, training, and real output. Obviously, for short periods operations deviate from the average, perhaps substantially. The model, however, assumes that such random deviations should not be included in planning or in evaluation.

Third, this model in no way attempts to measure combat effectiveness, or the military output, of any organization.

Fourth, it makes no effort to find the optimum outputs or inputs for any organization. That is, it does not try to gauge the efficiency of any sector's activities; instead the model provides a picture of the Marine Corps at a certain time.

Finally, the model does not consider the time path of adjustments to a new force structure. It does not prescribe how a new equilibrium is reached, how long it will take, nor how the system will change as it progresses towards an equilibrium. It specifies the quantity of resources needed to maintain a given change after equilibrium.

SUMMARY

REALM is structured as an input-output model. Thus, it provides rapid, accurate and consistent estimates of direct and indirect support costs. These indirect costs are created out of the many interconnected and specialized Marine Corps activities. Input-output models take into account these interrelationships by presenting the various input and output flows between Marine units.

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III. THE INTERIM CNA RESOURCE ALLOCATION MODEL

The Marine Corps "system" represented by the interim model contains elements drawn from the following FMF commands: the Second Marine Division and Force Troops at Camp Lejeune, North Carolina, and the organizations at Headquarters, FMF, Atlantic. It does not include air units of the FMF, Atlantic.

The infantry regiments, the direct and general support artillery battalions, and the other separate battalions of the Second Marine Division are each a separate sector in the interim model. Each battalion within Force Troops, similarly, is classified as a separate sector; the various separate companies within Force Troops, however, have been grouped into one sector. The component organizations that each combat sector contains is listed in table I.

TABLE I

COMBAT AND COMBAT SUPPORT SECTORS

Sector Number	
100	Infantry regiment
101	Direct support artillery battalion
102	General support artillery battalion
103	Reconnaissance battalion
104	Anti-tank battalion
105	Engineer battalion
106	Shore party battalion
107	Motor transport battalion
108	Medical battalion
109	Field artillery group
110	Tank battalion
111	Amphibian tractor battalion
112	Force engineer battalion
113	Communications battalion
114	Force motor transport battalion
115	Radio Battalion
116	Aggregated Separate Force Troops Organizations

In addition, the interim model includes all units that render some supporting service to these FMF, Atlantic, units. These commands include: Quantico, Virginia; the Recruit Training Depot, Parris Island, South Carolina; the base facilities at Camp Lejeune; and the Marine Corps Supply Depot at Albany, Georgia. The component organizations in each support sector is listed in table II.

Several schools in California have no counterpart in the east. Since they train a significant number of highly skilled technicians for organizations included in the model, they have been separated from their parent commands and included in the model. They are the Communications Electronics School at the Recruit Training Depot, San Diego, and the Schools Battalion at Camp Pendleton.

The following outlines the major points considered in constructing the sectors.

FINAL USERS

FMF ground combat units, excluding, major headquarters and support activities such as the Force Service Regiment, are considered final users. These combat units are central to decision making, in that most crucial command and strategic choices concern them, their location, size, mission, structure and support needs. The input and output requirements of the support units reflect the decisions on combat units and not the reverse.

SUPPORTING UNITS

The treatment of each supporting sector had 2 steps. The first was to measure that sector's output (support). The second was to determine the flow of this output to the various users. In many cases, constraints on either problem affect the way that the sector was treated.

Wherever possible, a physical measure of the support from each sector was used. In certain cases the output is not readily identifiable, very often because it consists of many diverse and relatively small services rendered for many sectors. In these cases, including command and control, a proxy was developed to provide an index of support for such sectors.

The following are the principal supporting units in the interim model.

Service Battalion/Regiment.

Although the FMF ground organizations are combat units, their service organizations are considered as supporting units. They provide support to other organizations within the commands. These service organizations reflect 2 different activities. In the first, maintenance, output is measured in hours spent maintaining equipment. In the supply sector, output is measured by requisitions processed.

TABLE II

SUPPORT SECTORS

Sector Number	Organizational Name
1	Headquarters and Service Battalion, FMFLant
2	Headquarters Battalion, 2d MarDiv
3	Headquarters and Truck Company, Service Battalion, 2d MarDiv
4	Supply Company, Service Battalion, 2d MarDiv
5	Maintenance Company, Service Battalion, 2d MarDiv
6	Headquarters Company, Force Troops, FMFLant
7	Headquarters and Service Battalion, Force Service Regiment
8	Maintenance Battalion, Force Service Regiment
9	Supply Battalion, Force Service Regiment
10	FMFLant Programs
11	Camp Garcia
	MCB Lejeune
12	Headquarters Company, Headquarters and Service Battalion
13	Guard Company, Special Service Section, Service company, Headquarters and Service Battalion
14	Maintenance Department, Headquarters and Service Battalion
15	Motor Transport Company
16	Base Materiel Battalion
17	Rifle Range Detachment
18	Infantry Training Regiment
19	Engineering School
20	Headquarters Company of Marine Corps Service Schools
21	Supply Schools Company, MCSS
22	Motor Transport School, MCSS
23	Food Service School, MCSS
	MCDEC Quantico
24	Headquarters Battalion
25	Headquarters Company, Service Battalion
26	Motor Transport Company, Service Battalion
27	Service Company, Service Battalion
28	Materiel Division, Service Company, Service Battalion

TABLE II (CONTINUED)

Sector Number	Organizational Name
	MCDEC Quantico (Cont'd)
29	Maintenance Branch, Service Company, Service Battalion
30	Schools Demonstration Troops
31	Weapons Training Battalion
33	Marine Corps Education Center
34	Officer Candidate School
35	Basic School
36	Ordnance School
37	Ordnance School Maintenance
38	Women's Officer School
	MCRD Parris Island
39	Headquarters and Service Battalion
40	Maintenance Dept., Service Co., Hq. and Service Battalion
41	Recruit Training Regiment
42	Weapons Training Battalion
43	Recruit Training Regiment (Women)
	MCRD San Diego
44	General Base Support
45	Motor Transport
46	Maintenance Department
47	Communications and Electronics School Battalion
	MCSC Albany
48	Headquarters Bn., Admin. Serv. Div., Comptroller Div., Motor Trans.
49	Maintenance Branch
50	Materiel Division
51	Repair Division
	MCB Pendleton
52	Schools Battalion

Base Support.

Base maintenance, motor transport facilities and maintenance shops are treated as separate support sectors.

Base maintenance, however, provides 2 services: maintaining buildings and real property, and supplying utilities. Both are included in a single measure of output that shows the percentage of total maintenance resources that each activity uses. Such proportional measures of output were based on percentage of total building space that the organizations in each sector occupy.

Marine Schools.

All Marine schools, from recruit training to communications-electronics, are handled as separate supporting sectors. In every case their output is the number of Marines trained in one year.

Supply Center.

The Marine Corps Supply Center at Albany Georgia, is divided into those activities that provide supply support, such as most of the Material Division, and those that support the Repair Division. The "output" of the Repair Division to each sector shows the proportion of the Repair Division's total resources necessary to provide that sector with fifth echelon maintenance.

PRIMARY INPUTS

Operating expenses, called primary inputs, shown for each sector in the interim model include:

- Payments from Operations and Maintenance Funds (O&M,MC), including civilian salaries.

- The value of goods provided to the sectors by the Appropriated Stores Account (ASA). Goods so provided include only those used for normal operations and maintenance. They do not include initial equipment issues.

- Pay and allowances for the Marines in each organization, from the Military Pay, Marine Corps account.

Costs Not Included.

This interim model does not include:

- Initial procurement and outfitting costs. These are prepared and kept current in Marine Corps Headquarters (A04G). These figures can be easily added to the operating costs produced by the interim model to determine the costs of introducing a new organization.

- Navy Appropriations.

- Military Construction (MilCon).

- A few other costs, such as family housing and commissary activities, have not been included because they are not directly related to Marine military activity.

SUMMARY

The Interim Model contains ground units of the FMF, Atlantic, and all organizations providing them with direct or indirect support. Wherever possible, this support was measured in specific units. In some cases, proxies had to be used.

IV. USE OF THE INTERIM MODEL

A basic function of the cost model is answering questions about the effect on operating costs of alternative Marine Corps force levels, organizational structures, and equipment. The interim model determines operating costs sector by sector for each alternative.

The following examples are representative of cost questions that the interim model can answer. First, there are manning level questions affecting the whole Marine Corps. For example: What happens to operating costs if the Marine Corps increases the number of men in each organization by 20 percent, or decreases it by 50 percent?

Questions about more selective, or structural, changes can also be handled. These are likely to be the most frequently asked. For example: how will operating costs change if one infantry regiment is added to those in the model? These operating costs before and after the change will be shown for each sector. An example of this type of question is presented below as the first hypothetical question.

A third kind of question concerns the introduction of new equipment. New equipment changes the demand made upon the processors, and hence affects resource requirements and operating costs. These changes can be predicted by the model provided that assumptions about support requirements are made and appropriate data is entered in the model. The second hypothetical question below examines such a question.

Not all the above questions can be answered solely with the information in the interim model. Questions on force level and organizational changes can be answered with the available data, unless organizations are added that are not already in the model. Estimating in operating costs of introducing new equipment, however, requires additional information.

GENERAL PRINCIPLES FOR USING THE MODEL

A "customer" who wants a problem solved by the cost model must provide information in a certain sequence before the model can produce usable costs. As an example, 2 hypothetical problems will be considered in detail:

- What would it cost in terms of changes in operating costs to introduce an additional infantry regiment at Camp Lejeune, North Carolina, assuming it would be identical to those located there.

• What would be the net effect on operating costs of deleting the present anti-tank battalion and substituting another battalion organized around a new weapon that we will call "X."

Preliminary Steps

Figure 4 permits the reader to graphically follow the problem. Its data, hypothetical and solely for illustration, shows a Marine Corps consisting of 4 supporting organizations and 2 combat organizations. To answer the first question, the customer would identify the infantry regiment as Sector 5. Reading down column 5, he can identify the inputs from the processor organizations. Thus, in column 5, row 1, the number "10" shows that Maintenance Company provides 10,000 man-hours of 3rd echelon maintenance. Similarly, each value in the column shows the flow that each other processor directly provides to the infantry regiment. Since the new infantry regiment is identical to that in the model, adding the new infantry regiment requires no new information. The model simply doubles the values found in Sector 5. Figure 5 shows this change and the resulting changes in the budgets and outputs of the processors.

Now consider the effect of introducing battalion "X." The anti-tank battalion is Sector 6. The customer must replace the figures for the anti-tank battalion with data for battalion "X." He obtains the necessary data by answering the following type of questions. What is its Table of Organization and Equipment; What will be its training tempo? What are its external support requirements? Are they similar to the anti-tank battalion, or unique?

Once these new flows have been determined, a new sector is created showing these values (column 7 in figure 6).

The customer then determines the operating costs of the new organization: Military Pay, Operations and Maintenance costs, and ASA operating expenses. In the example adding a new infantry regiment, the operating costs shown for the regiment in the model is simply doubled. In the second example, the operating costs for the anti-tank battalion is replaced by the operating costs of battalion "X." Military Pay would be determined by the new Table of Organization and Costing II, a computer program internal to the model. The other operating expenses could be determined partly from the original study that first considered battalion "X" and possibly from comparisons with existing organizations.

Figure 6 summarizes the changes given above and shows that Column 6, the anti-tank battalion, contains only zeros, reflecting the elimination of the anti-tank battalion. The estimated values for Battalion "X" are in column 7.

Columns 1 through 4 show the outputs that the processors must now supply to support battalion "X" instead of the anti-tank battalion.

		(1) Maintenance Co.	(2) Motor Transport	(3) Repair Maintenance	(4) Recruit Depots	(5) Infantry Regiment	(6) Anti-tank Battalion	(7) Battalion X	Total Services	
(1)	Maintenance Co.	3	5	5	7	10	10		40	thousand hours of service
(2)	Motor transport	2	4	6	8	20	0		40	thousand miles driven
(3)	Repair maintenance	4	6	5	10	25	5		55	thousand hours
(4)	Recruit depots	10	30	10	20	130	20		220	men trained
	Operating costs for each sector	100	200	100	200	200	100		900	thousand dollars

FIGURE 4

(1)	Maintenance Co.	5	10	9	13	20	10		67	thousand hours of service
(2)	Motor Transport	3	8	11	15	40	0		77	thousand miles driven
(3)	Repair Maintenance	7	11	9	19	50	5		101	thousand hours
(4)	Recruit Depots	17	58	18	37	260	20		410	men trained
	Operating costs for each sector	167	385	184	373	400	100		1608	thousand dollars

FIGURE 5

(1)	Maintenance Co.	4	5	5	8	10	0	15	47	thousand hours of service
(2)	Motor Transport	2	4	7	9	20	0	0	42	thousand miles driven
(3)	Repair Maintenance	5	6	5	11	25	0	7	59	thousand hours
(4)	Recruit Depots	12	31	11	21	130	0	30	235	men trained
	Operating Costs for each Sector	116	208	108	214	200	0	200	1046	thousand dollars

FIGURE 6

Printed Results

After the information established in the preliminary steps has been put on cards, a computer run produces the cost projections. The printout shows the old, new, and net changes in both outputs and operating costs for every sector affected (not every sector is affected in every problem). The dollars are shown by appropriation categories (except in these examples, where only the total operating costs are shown for simplicity). Figure 7 shows these results for the problem, where an infantry regiment is added. Figure 8 shows the results for the problem of adding battalion "X".

Analysis of Changes in Operating Costs

The printout shows the operating costs for combat and support organizations. The old gives the cost to maintain the existing tempo of operations. The new and difference figures express the dollar effect from the specified changes in combat units. Figure 7 shows that the additional regiment would cost $708, of which only $200 is due to the increased budget of the infantry regiment. The other $508 is due to the increased expenses of the support establishment.

Similarly, figure 8 shows that battalion "X" costs $146 more than the anti-tank battalion. Of this, one-third is due to the greater support requirements of battalion "X".

Other Interim Model Uses

The interim model is not limited to measuring the effect on dollars and resources of changes in combat organizations. It can also provide information on current operations. For example: What is the average cost of putting a new lieutenant into the FMF? A computer run would show the net effect for each sector contributing directly or indirectly to the procurement and training of one lieutenant.

SUMMARY

In this chapter we have shown how a user of the cost model would proceed to answer 2 sample questions, one changing the number of combat organizations, the other changing the structure of the combat organizations. These sample questions are only designed to introduce the workings of the cost model. By no means do they indicate the range of questions the model can answer. On the contrary, they are only a small sample of the wide variety of questions on costs and resources that the model can answer.

Sector outputs

Sector	Old	New	Difference
1 Maintenance Co.	40	67	27
2 Motor Transport	40	77	37
3 Repair Maintenance	55	101	46
4 Recruit Depots	220	410	190

Sector operating costs

Sector	Old	New	Difference
1 Maintenance Co.	100	167	67
2 Motor Transport Co.	200	385	185
3 Repair Maintenance Co.	100	184	84
4 Recruit Depots	200	373	173
5 Infantry Regiment	200	400	200
6 Anti-Tank Battalion	100	100	0
Total System Budget	900	1608	708

FIGURE 7

Sector outputs

Sector	Old	New	Difference
1 Maintenance Co.	40	47	7
2 Motor Transport	40	42	2
3 Repair Maintenance	55	59	4
4 Recruit Depots	220	235	15

Sector operating costs

Sector	Old	New	Difference
1 Maintenance Co.	100	116	16
2 Motor Transport Co.	200	208	8
3 Repair Maintenance Co.	100	108	8
4 Recruit Depots	200	214	14
5 Infantry Regiment	200	200	0
6 Anti-Tank Battalion	100	0	-100
7 Battalion X	0	200	200
Total System Budget	900	1046	146

FIGURE 8

REFERENCES

(a) Headquarters, Marine Corps Order 5250.1, "Policies and Procedures for the Development and Implementation of the Marine Corps Cost Model", 27 Jun 1966

(b) OASD (Comptroller) ltr "OSD Proposed Cost Model Ground Rules," pp. 2-3, Jan 1964

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Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*

Marine Corps Operations Analysis Group, Center for Naval Analyses, an affiliate of the University of Rochester

2a. REPORT SECURITY CLASSIFICATION

None

2b. GROUP

None

3. REPORT TITLE

Interim-Input Output Resource Allocation Model

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Research Contribution - March 1970

5. AUTHOR(S) *(First name, middle initial, last name)*

Augusta, J.H., Jenner, R.A., and Ryhanych, G.W.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
March 1970	24	2

8a. CONTRACT OR GRANT NO. N00014-68-A-0091

b. PROJECT NO.

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

Marine Corps Operations Analysis Group
Research Contribution No. 134

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

None

10. DISTRIBUTION STATEMENT

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of HQUSMC (AX).

11. SUPPLEMENTARY NOTES

None

12. SPONSORING MILITARY ACTIVITY

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13. ABSTRACT

This research contribution describes the Interim CNA Input-Output Resource Allocation Model. This model is an "input-output" model, which accounts for and allocates indirect operating costs created by the many interactions between Marine Corps units. The cost model provides 3 types of information. One, it provides direct operating cost for all Marine Corps organizations on the east coast, both Fleet Marine Forces (FMF) and non-FMF. Second, it allocates the operating costs of the support establishment (normally called indirect support costs) to the FMF units receiving the support. Third, it provides estimates of the effect of any specified change in the FMF upon the support establishments' operating costs, and estimates the needed additional resources, including manpower, of the change.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

None

Security Classification

None

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Input-Output						
Resource Allocation Model						
Fleet Marine Forces						
Indirect support costs						

DD FORM 1 NOV 65 1473 (BACK)

(PAGE 2)

None

Security Classification